DAVID RENFREW OIL RIG
East side of Connoquenessing Creek, .4 mile
north of confluence with Thorn Creek
Renfrew Vicinity
Butler County
Pennsylvania

HAER No. PA-281

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

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Butler County
Pennsylvania

UTM: 17.588210.4518250
Quad: Butler, Penn., 1:24,000

Date of Construction:

Circa 1900

Present Owner:

Bessemer & Lake Erie Railroad
Monroeville, Pennsylvania

Present Use:

Abandoned Oil Rig

Significance:

Historically significant as a relatively rare survivor of the early-twentieth-century oil industry in southwestern Pennsylvania, and for its location in the Bald Ridge oil field. Technologically significant as representative of the first generation of steel derricks and the oldest type of pumping apparatus, relying on a large, belt-driven, wooden band wheel for pumping power.

Project Information:

This documentation was performed in late September/early October 1992 for CNG Transmission Corporation of Clarksburg, West Virginia, to mitigate the adverse effect of long-distance pipeline installation through the site's location. The Pennsylvania Bureau for Historic Preservation and the Federal Regulatory Energy Commission required this documentation for compliance with Section 106 of the National Historic Preservation Act of 1966.

Michael Petraglia, Ph.D., Project Manager; Christopher Martin, M.A., Senior Architectural Historian; Frances Alexander, M.A., Senior Architectural Historian; Madeleine Pappas, M.A., Historian; Patrice Gilbert, B.A., Photography; Sulah Lee, B.A., Graphics.

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INTRODUCTION

The David Renfrew Oil Rig was first identified and documented during Phase I and II archaeology investigations conducted by Engineering-Science for CNG Transmission Corporation during 1991 and 1992 (Petraglia, Knepper, Martin and Rosenthal 1992; Petraglia, Knepper, Martin, Heston, Pappas and Alexander 1992). This industrial site is No. 36BT269 in the inventory of the Pennsylvania Bureau for Historic Preservation, Division of Archaeology. This HAER report builds upon previous research included in the two archaeological reports cited above, particularly the Phase II report.

While conducting research on this industrial site, it became apparent that the western Pennsylvania oil industry still awaits the kind of systematic, comprehensive documentation currently directed at the coal, iron, steel, and transportation industries in southwestern Pennsylvania, which are the primary components of the "America's Industrial Heritage Project" directed by the National Park Service. The early phase of the oil industry has been relatively well documented, particularly in the Titusville/Oil City area, but its later phases (and corresponding oil regions) in the late nineteenth and early twentieth centuries deserve more intensive study. It is hoped that this report will raise an awareness of the historical richness, geographical scope, and longevity of western Pennsylvania's oil heritage.

DESCRIPTION OF SITE/STRUCTURE

Location

The D. Renfrew Oil Rig is located in the oil region of western Pennsylvania, in southcentral Butler County, approximately .5 miles north of the village of Renfrew, between two adjacent oil pools historically known as the Bald Ridge and Thorn Creek oil fields (see **Location Map, Pennsylvania Oil Fields**). The site lay on the level floodplain/terrace of the east side of the Connoquenessing Creek, about 200 feet from the creek bank. The setting is a narrow strip of terrace between the creek and the base of the high, ballasted embankment of the Bessemer & Lake Erie Railroad, which follows the creek valley. The entire terrace, including the site, is covered in secondary forest growth.

This well survives partly due to its inaccessibility. While most abandoned rigs have been taken apart for scrap metal or disturbed by trespassers, this rig is located deep within the creek valley below the railroad tracks, and is nearly invisible among the thick woods.

Site Evolution

The D. Renfrew Oil Rig is located on property that belonged to David Renfrew when mineral exploration first began. At one time, Renfrew owned about 600 acres of land in the vicinity of the Connoquenessing Creek, yet by the end of his life he retained only 200 aeres in this vicinity (*History of Butler County, Pennsylvania* 1895).

Renfrew leased mineral rights for portions of his land to independent speculators as well as oil companies (*History of Butler County, Pennsylvania* 1895). The D. Renfrew Oil Rig is located in the Bald Ridge oil field, centered around the junction of the Connoquenessing and Thorn Creeks, Butler County, where oil was first struck in the spring of 1881. Its location is at the field's eastern edge, where the field joins the highly productive Thorn Creek field, located directly east along the north side of Thorn Creek.

The rig is located on an 80-acre tract that David Renfrew first leased for oil exploration in March 1882, to W. V. Hardman of Venango County. The lease extended 20 years for the purpose of boring, mining, and excavating for petroleum and gas, as well as for piping the product. It was agreed that Renfrew would receive a one-eighth portion of any petroleum found, which was the standard royalty for landowners (Butler County Deed Book 64:213). About a year later, Hardman transferred his interests and claims, totalling 46 oil leases and including the 80-acre Renfrew lease, to E.I. Agnew (Butler County Deed Book 76:226). Agnew was active in exploring the Bald Ridge field, and teamed with a partner to operate under the name of Agnew and Egbert (*History of Butler County, Pennsylvania* 1895). By March 1886, the 80-acre lease had been sold to D. Osborn, who in turn sold the mineral rights for that tract and an adjacent 50 acres to the east (part of the William C. Wallace farm) back to Renfrew for $9,000. In 1886, there were six producing wells on these two tracts (Butler County Deed Book 101:66; 157:270).

Located east of the Connoquenessing Creek and north of Thorn Creek, the D. Renfrew Oil Rig was on property adjoining two of the most prolific oil-producing farms in the Bald Ridge oil field. To the north of Renfrew's land, on both sides of the Connoquenessing Creek, was the McCalmont farm, where the most productive oil wells in the Bald Ridge field were found. To the east was the large, 300-acre Wallace farm, described in county histories as "one of the most valuable farms in the [Bald Ridge] district outside of the McCalmont tract" (McKee 1909). According to the 1886 Heydrick map, most success on Wallace property occurred in the northwest corner, adjacent to the McCalmont tract (see **Detail of Bald Ridge and Thorn Creek Oil Fields, 1886**).

David A. Renfrew died in 1899, leaving his land to his two sons. The land where the D. Renfrew Oil Rig is located remained in the Renfrew family until 1921, when Ira and Sarah Renfrew sold a 7-acre parcel between the Connoquenessing

Creek and the Pittsburg, Bessemer and Lake Erie Railroad tracks (currently the Bessemer and Lake Erie Railroad) to Mrs. Ruth M. Wilson of Renfrew. The deed reserved all rights to coal, oil and gas reserves for the Renfrew heirs (Butler County Deed Book 385:355). In 1947, the Pittsburg, Bessemer, and lake Erie Railroad acquired the 7-acre parcel, and continues to own the property today.

By 1955, the Franklin Glass Company had secured an oil/gas lease for the property including the D. Renfrew Oil Rig from the Renfrew heirs. With its main plant based in Butler, in 1941 Franklin Glass bought the brick building, located at the junction of the Connoquenessing and Thorn Creeks, used between 1928 and 1940 by the Clearview Glass Company followed by the West Penn Glass Company, both based in Butler (Butler County Deed Books 451:127; 506:166). The brick building was originally built in 1907 as a coal-fired electricity generating plant for the Pittsburgh and Butler Street Railway, an electric interurban railroad that paralleled the Pittsburgh, Bessemer and Lake Erie (on its eastern side, on the other side of the current B. & L.E. tracks from the D. Renfrew Oil Rig) through this part of the Connoquenessing Valley. The Pittsburgh and Butler Street Railway ceased operation in 1931, after which its power plant was converted into a small glass plant (Fronczek Interview 1992). The Franklin Glass Company undoubtedly leased surrounding land in search of natural gas to assist in powering their plant.

There are no well records for this well at the Pennsylvania Topographic and Geological Survey, Oil and Gas Geology Division, located in Pittsburgh. This agency has well records for some wells in western Pennsylvania; however, documented wells are a relatively small proportion of the total, and systematic recording of well production did not begin until the early twentieth century. This oil well may have been drilled during the Bald Ridge oil field's initial exploration beginning in 1881. A producing well in its location appears on the 1886 *Heydrick's Map of the Oil Field from Thorn Creek to Shannopin* (see **Detail of Bald Ridge and Thorn Creek Oil Fields, 1886**). This well site does not appear on the 1936 Richardson oil and gas map, which only shows producing wells, but it does appear as an actively productive well on the 1955 Lytle and Heeren *Oil and Gas Field Atlas of the Butler Quadrangle* (see **Detail of Oil/Gas Leases in Butler County, 1955**). It is possible that the well was abandoned after its most productive phase (immediately after drilling) and then re-opened when secondary recovery was attempted in the 1940s or early 1950s.

According to Earl Kennedy, the owner of neighboring property to the east also containing remains of another oil rig, the D. Renfrew Oil Rig was pumping as late as 1950, but he was not sure if it was pumping oil or water. Kennedy related that this area gradually became "watered out" when a lot of water entered its oil sands (Kennedy Interview 1992). This information was confirmed by William Lytle's 1950 assessment of crude oil reserves in Pennsylvania, noting the traditionally high proportion of water in the Renfrew-McCalmont area of the Bald Ridge field. Lytle also reports, however, that wells there increased their production

of oil due to accidental flooding--probably caused by poorly plugged wells, as in the neighboring Thorn Creek field--and that in 1950 the average daily production in the Renfrew-McCalmont area was about 1 barrel of oil (Lytle 1950).

According to Earl Kennedy, there was a problem of access to the D. Renfrew Oil Rig due to its location on a narrow strip of land between the railroad and the creek. In the early twentieth century, the Bessemer and Lake Erie railroad had a crossing nearby, but eventually the crossing was removed and access was restricted in this vicinity. Probably due to safety factors, the railroad company refused to allow transport of oil-related equipment across its tracks (Kennedy Interview 1992).

Physical Description and Operation

The structure covers an area measuring approximately 60 feet east-west x 90 feet north-south. It consists of the remains of an abandoned oil well, pumping apparatus and derrick, known collectively as an oil "rig." The structure last operated about 35 years ago, and its wooden components have deteriorated badly due to exposure to weather. This rig was last used for pumping; any drilling equipment has long since been removed from the site. The structure currently consists of a collapsed frame engine house and engine, iron and wooden pumping mechanism, tubular metal derrick, oil storage tank, iron pipelines, and fragments of the wooden housing that protected the pumping assembly from weather (see **Site Plan**).

In the Pennsylvania oil region all major components, including the lower portion of the derrick, were usually protected from weather by a wood frame housing. In supply catalogs dating from circa 1900, protected rigs of this design were referred to as "winter rigs" (Oil Well Supply Company 1902) (see **Enclosed Oil Rig, C.1902**). At the time of this documentation, the wood frame engine house was collapsed, due partly to a fallen tree. Photographic documentation of the structure occurred both before and after the engine house roof was removed to expose engine components. Remnants of the frame housing and corrugated tin roof that protected the belt and band wheel were found scattered on the ground around the structure. A small piece of the housing surrounding the band wheel survives in an upright position.

The rig's major components are the engine, the pumping assembly, and the derrick. The engine crankshaft powered a belt attached to a large, wooden band wheel, which moved the walking beam up and down. The other end of the walking beam, centered over the well head, raised and lowered a series of rods with valves at the bottom, which raised the oil by displacing air in the pipe "tubing" surrounding the rods. The extracted oil was then piped to a receiving tank on site, and then piped directly to gathering pipelines carrying the oil to a large pumping station in the vicinity, where it was transported to a refinery through larger, long-distance pipelines or by truck.

The derrick was used when a well was drilled, and was often left standing over relatively deep wells to allow greater lengths of tubing to be pulled out of the well at one time. The bull wheel, located in line with the derrick legs farthest from the engine, was used to spool the drilling line, which ran through the crown pulley at the top of the derrick and down the well during drilling; a calf wheel, opposite the bull wheel, was used for spooling the line that raised and lowered the casing. Both the bull wheel and the calf wheel were powered by an inner tug pulley on the band wheel. After a well was drilled, the bull wheel was usually used to store cable attached to rods and tubing, making the calf wheel unnecessary. This rig did not have a calf wheel when this documentation occurred (see **Typical Oil Rig Set Up for Pumping, C.1900).**

The approximate dimensions of the deteriorated engine house are 15 x 13 x 6 feet tall. The wood frame and weatherboard construction was secured with tapered, cut nails. Wire nails are evidence of later patching. According to Earl Kennedy, a neighboring property owner, tapered nails were used in oil rigs because they could be easily removed, allowing the structures to be disassembled and moved to another site if the well became unproductive (Kennedy Interview 1992). The corrugated tin roof of the engine house is not original, probably replacing an original wood shingle roof.

Beneath the fallen engine house roof lay a heavy wooden timber (the engine block) measuring 19 x 19 x 110 inches, with numerous insets and bolt holes for the metal fittings and anchor bolts of previous engines. The engine block was treated with creosote to prevent rotting (Petraglia, Knepper, Martin, Heston, Pappas and Alexander 1992). The block lay on two wooden mud sills, each measuring 14 x 14 x 111-$^1/_2$ inches. The last engine used to drive the rig survives at the site. It is a flathead 6-cylinder automobile engine, dating from circa 1920. The engine is mounted on an automobile chassis that turned upside down and bolted to the engine block timber. A metal carburetor has printing that reads "Carter Carburetor Corp., Saint Louis, USA." Additional printing on the carburetor reads "BA & BALL Carburetor Mfd for Chrysler Corp., Detroit, Mich, USA." The carburetor dates from c. 1930-1940.

Two parts of an earlier single cylinder, internal combustion, natural gas engine used to power the rig were scattered on the ground near the engine house. These were an engine cylinder and crankshaft/clutch assembly. These natural gas engines were typically about 15 horsepower. The large cylindrical tank immediately east of the engine house is made of riveted steel, measuring 3 feet 2 inches in diameter x 6 feet 4 inches in length. It was probably used as a cooling tank that held water to cool the engine.

The crankshaft of the gasoline-powered engine is attached to a small drive pulley, which powers a 7-inch-wide belt that moves the large wooden band wheel. Portions of the canvas belt survive. The band wheel, measuring 9 feet 4 inches in

diameter and 12 inches thick, is constructed of 8-ply lumber secured with cut nails and bolts. The tug pulley (the interior rim of the band wheel) measures 6 feet 6 inches in diameter and held a rope or cable that turned the bull wheel, whose spooled cable in turn raised and lowered rods and tubing inside the well. The iron core of the band wheel, known in the industry as a "rig iron," measures 2 feet 10 inches in diameter and displays the name "Oil Well Supply Co. Ltd., Oil City, Pa." As advertised in their supply catalog, the Oil Well Supply Company designed these large band wheels to be assembled on site (Oil Well Supply Company 1916).

The vertical metal jack posts supporting the band wheel are constructed of 6-inch-diameter pipe, secured in concrete at the base. Near ground level the jack posts are connected to two horizontal pipes ("bunting poles"), connected to the engine block to stabilize the band wheel. One of the bunting poles is slightly displaced from its original position (see **Site Plan**).

The jack posts are topped by oak bearing blocks cut out to receive the band wheel axle. The home-made character of the bearing blocks, as opposed to the usual cast iron bearing blocks, suggest that this rig was maintained by a cost-conscious individual. The band wheel axle is connected to a cast iron wrist pin, designed with three hole settings to accommodate pitmans of different lengths. This rig has a large, hand-hewn wooden pitman of the type used on the earliest rigs. The top of the pitman is attached to an iron stirrup, bolted to a horizontal walking beam made of double metal pipes, each measuring approximately 5 inches in diameter. The walking beam is supported by a vertical metal samson post made of double pipe, each measuring 7 inches in diameter. This heavy samson post is anchored in concrete.

The end of the walking beam nearest the derrick has become detached from the linkage connected to the top iron "polished" rod, which during operation would have been attached to other "sucker" rods running the length of the well and housed inside iron pipe "tubing." The bottom sucker rod was connected to a valve rod, in turn connected to two ball-and-seat valves separated by a working barrel, which brings oil up via displaced air. On the downstroke, the oil pressure held the top ("working") valve closed, while the bottom ("standing") valve opened, allowing the working barrel to pass through the fluid. On the upstroke, the standing valve was closed by the pressure of the oil column, and oil was trapped in a working barrel. The relatively small diameter of oil well tubing required a long working barrel to displace a significant volume (see **Detail of Typical Pumping Assembly, C.1900**). Pump speeds typically ranged from 10 strokes per minute to as high as 20 strokes per minute for lighter grades of oil (Phelps and Lake 1924; Leven 1941).

The sucker rods operated within iron tubing measuring about 2 inches in diameter. The tubing was inserted inside "casing," measuring about 5 inches in diameter. The casing was inserted inside an exterior "drive" pipe, measuring about 8 inches in diameter, but not visible above ground level at this well. The casing head

is screwed onto the top of the casing pipe and secured by a clamp. Just above the casing head clamp, a short length of threaded horizontal pipe 2 inches in diameter extends from the tubing. Its purpose was to carry natural gas away from the well head, or back to the earlier natural gas engine. Another horizontal pipe extends from the tubing about 6 feet above the ground. It was used to transport oil to the cylindrical oil receiving tank, located slightly downgrade from the northwest corner of the derrick. The steel tank has welded seams and measures approximately 4 feet 6 inches in diameter and 8 feet tall. The base of this tank is partially below ground. The broken ladder currently resting against the receiving tank is part of the original derrick ladder.

The derrick is centered over the well head. It is constructed of $2^{1}/_{2}$-inch-diameter tubular steel pipe bolted together. The derrick is approximately 75 feet tall. Its legs are 18 feet $6^{1}/_{2}$ inches apart, resting on a foundation made of 5-inch-diameter double parallel pipes 19 feet 10 inches long. The derrick consists of eight panels, each strengthened by cross-bracing in an "X" pattern, with the crossing members secured by U-bolts. The braces and horizontal girts are constructed with flattened ends that are bolted together in a pattern known as the Simpson joint (Brantly 1971). The crown pulley at the top of the derrick consists of two pulleys. The lower part of the 22-inch-wide derrick ladder is deteriorated and laying on the ground. The derrick is generally very rusty; over time, several hraces have come apart and now hang down.

At the south end of the derrick is the bull wheel, used when pulling sucker rods, tubing, or casing out of the well for cleaning and maintenance. The bull wheel was originally mounted on heavy, hewn vertical wood posts and stabilized by vertical boards bolted to the two southemmost derrick legs. The posts have rotted and the bull wheel now lays on the ground. The bull wheel was used to take up slack in cable threaded up through the crown pulley and attached to rods or tubing. Remnants of the $^{3}/_{4}$-inch-diameter woven wire cable last used at the site survive. The bull wheel axle measures approximately 12 inches in diameter. Its hub displays the name "National Supply Co., Toledo, Ohio." The bull wheel flywheels are each different; the one with curved spokes was probably originally used on an old steam engine. The bull wheel also has a brake.

Also inside the base of the derrick is a vertical tubular metal "telegraph" post with a small throttle wheel mounted on it, once connected directly by cable to the engine throttle, so that the engine speed could be monitored by someone working at the well head. This metal post has fallen into the side of the derrick.

BACKGROUND INFORMATION ON THE OIL INDUSTRY IN WESTERN PENNSYLVANIA AND BUTLER COUNTY

Geological Context

The D. Renfrew Oil Rig is located in the Pennsylvania oil region, which produces a paraffin-based oil regarded for its excellent lubricating ability when exposed to the high temperatures of internal combustion gasoline engines. The western Pennsylvania oil region is geologically part of the northern Appalachian oil and gas region, an elliptically shaped area that extends from Ontario through New York, Pennsylvania, Ohio, West Virginia, and eastern Kentucky. The location of oil, gas, and coal in this region is determined by the structure of underlying rocks. Subsurface rock layers are not flatly stratified but form a series of long, narrow hasins (synclines) running northeast-southwest, separated by equally long divides (anticlines), sometimes corresponding with surface ridges (Sisler *et al.* 1933; Ashley and Robinson 1922).

It was not until the third Pennsylvania Geological Survey, however, completed in 1914, when it was realized that the underlying rock folds were very irregular. As the western border of Pennsylvania is approached, the folds sometimes run perpendicular to the main northeast-southwest folding orientation. The disruptive folding that has driven oil and gas out of rocks east of the Allegheny Front decreases gradually west of the Front, preserving oil and gas in that region. Within Pennsylvania's oil and gas belt, gas is usually found east of oil, corresponding to a greater percentage of gases and volatile matter in the bituminous coal (Ashley and Robinson 1922).

Oil and gas were formed from partially decomposed plant and animal matter caught among layers of rock deposited in the ocean during dramatic shifts of the earth's crust. Concentrations of oil and gas are commonly referred to as "pools" or "fields." Concentrations do not occur in underground cavities, however, but in the open spaces between the grains of coarse-grained sandstones, porous limestones, or other rock. Oil "sands" lie underneath finer grained rocks that prevent oil and gas from escaping to the surface. For concentrations of oil and gas to occur, there must be sufficient natural pressure to separate oil, gas, and water, and force oil up through a drilled well. Most oil wells stop flowing naturally due to loss of gas pressure, rather than to exhaustion of oil; this condition allows secondary recovery through various methods of repressurization (Ashley and Robinson 1922).

In Pennsylvania, oil wells vary in depth from less than 200 feet to about 3,000 feet. Compared to the relatively shallow wells of the "upper" Pennsylvania oil district (centered in McKean County), Butler County wells were relatively deep, averaging between 1,500 and 2,000 feet, sometimes reaching 3,000 feet (Ashley and Robinson 1922). Butler County is located in the "lower" oil district, which includes parts of nine counties in southwestern Pennsylvania. The average depth of oil wells

generally increases when moving from north to south through the 18 counties in the Pennsylvania oil region.

In Butler County, oil and gas pools become unevenly distributed moving from the large concentration in the northeast to the spotty, but often highly productive, pools in the eastern and southcentral portions of the county (see **Pennsylvania Oil Fields**). The oil and gas sands are generally fine- to coarse-grained in texture, commonly containing streaks of pebbles. They are composed chiefly of quartzose but also contain feldspars, flakes of mica, and some ferromagnesiam minerals embedded in clay, cemented by silica and subordinate calcite. The oil sands lie below the Vanport (Ferriferous) limestone level, which occurs about 300 feet below ground level. The oil sands are located between 340 and 2,200 below the Vanport limestone, and have "pay" (oil producing) streaks averaging between 2 and 10 feet thick. The most productive sand is the Hundred-foot, present in almost every well. Other productive horizons in the county include the Butler, Thirty-foot, Gordon, Fifth, and Speechley horizons. The largest wells in the Bald Ridge and Thorn Creek oil fields obtained their oil from the Third and Fourth sands at a depth of about 1,500 feet (Sisler *et al.* 1933; Richardson 1936).

Historical Development of the Oil Industry in Western Pennsylvania and Butler County

In the early twentieth century, petroleum replaced iron ore as Pennsylvania's second-most important (next to coal) extractive product. Petroleum, called "Seneca Oil" by Native Americans, was skimmed from the surface of springs along the upper Allegheny River and used by both Indians and early white settlers for medicinal purposes (Donehoo 1928). It was also used as a lubricant by white settlers, but it was not until 1859 that it was drilled successfully and extracted in large volumes. In that year, Edwin L. Drake drilled the first deep oil well in Titusville, in southwestern Crawford County, Pennsylvania. Drake's strike began a boom in the area, and by 1860, 74 wells were in operation between Titusville and Oil City. By the early 1900s, oil extraction occurred in 18 western Pennsylvania counties, with most activity occurring within a belt extending from McKean County in the north to Washington County in the southwest corner of the state (Doherty 1989).

The impact of oil discovery was tremendous due to petroleum's many uses as a fuel and lubricant. It could be refined into kerosene, used for illumination. Oil towns sprang up almost overnight as new fields were discovered, and large refineries were built in cities including Pittsburgh, Philadelphia, Cleveland, and New York. The invention of the automobile created an even greater demand for petroleum, but the discovery of new oil fields in other states--notably Texas, California, Kansas, and Oklahoma--greatly reduced Pennsylvania's oil producing rank by the early twentieth century. Pennsylvania's peak production occurred in 1891. In 1900, the fields of Appalachia (including western Pennsylvania) and Indiana produced 95% of U.S. oil,

but by 1905 output from these two areas fell to 40% of total production (Doherty 1990; McLean and Haigh 1954). By 1920, Pennsylvania had fallen to 10th place compared to other oil producing states (Ashley and Robinson 1922). By 1946, it was estimated that approximately 80% of Pennsylvania's petroleum fields had been developed (Miller 1946). By 1970, Pennsylvania produced $^1/_9$ of 1% of the nation's oil. The impact of the Pennsylvania petroleum industry is still felt, however, through its prized lubricating oil and the growth of the state's refining capacity, currently second only to Texas (Klein and Hoogenboon 1980).

Butler County maintained a rank among the top three oil-producing Pennsylvania counties (with McKean and Venango) from 1889 into the 1920s (Hice 1916; Doherty 1989). Shortly after the discovery of oil in 1859 in the Oil Creek valley in Venango County, petroleum deposits were found in the valley of Slippery Rock Creek in northwestern Butler County. Hoping to repeat the success of the Drake well and attract some of the international attention focused on activity in Venango County, a number of companies were organized in Butler County in quick succession. The earliest oil company in Butler County was organized in 1860 as the Butler County Oil Company. The Butler Pioneer Oil Company was organized the next year and operations began on John Negley's tract southwest of Butler. In 1862, the Enterprise Oil Company was established at Prospect, and drilling by the company began along Slippery Rock Creek (*History of Butler County, Pennsylvania* 1895).

After the Civil War, several oil companies were formed throughout the oil region. A second firm using the name Butler County Oil Company was started in August 1865 when the directors leased 12,000 acres between Martinsburg and Millerstown, in northeastern Butler County. Although this belt later proved to contain rich petroleum deposits, these initial wells were not drilled deeply enough to reach oil, and the oil company was disbanded in disappointment. Ironically, these fields later produced some the largest wells found in Butler County to that date, when the firm of Shreve and Kingsley drilled a 140-barrel well on the Stewart farm in 1873. The Jacob's Oil Company, formed in 1868 by the directors of the first Butler County Oil Company, began exploration in the Martinsburg field, in Parker Township, and hit the first paying well in Butler County. The strike of the Martinsburg well proved that Butler County had oil fields worth developing (McKee 1909; *History of Butler County, Pennsylvania* 1895).

One of the most important Butler County oil operators was H.L. Taylor and Company, which began drilling in the county in 1871 and eventually owned 300 wells, 40 of which were located in the Petrolia, Millerstown, and Karns City fields (McKee 1909). The largest operator in the county during the 1870s, however, was an individual, Dunc Kearns, who in 1872 bought the prolific McClymonds farm, located in Fairview Township. Within a year the boom town of Karns City, named after Kearns, had arisen on the McClymonds farm. Kearns was also instrumental in the construction of a number of pipelines from Butler County to the Allegheny

River. After drilling was completed in the extensive oil belt from Parker's Landing south to St. Joe, southwest of Millerstown, Butler County was abandoned by oil scouts who moved explorations to the lucrative Bradford field in McKean County by the late 1870s (McKee 1909).

Oil was first discovered in the Connoquenessing Valley in May 1872 on the Jamison farm two miles north of Boydstown in Concord Township. Excitement centered around the Morrison well, which initially produced 700 barrels per day but quickly dropped to 300 and within a month to 150 barrels per day. Other gushers in the vicinity gave rise to the boom town of Greece City, which, according to one local history, "sprung up as if by magic, and in the fall of 1872 the surrounding country was dotted with derricks and drilling wells...." (McKee 1909). Overall production was inconsistent, however, and the Greece City oil pool soon became exhausted as exploration shifted to the Millerstown field in Donegal Township.

The D. Renfrew Oil Rig is located in the Bald Ridge oil field, centered along the Connoquenessing Creek at the junction with Thorn Creek. Exploration of this area began in 1880, when the firm of Reiber Huselton of Butler leased 780 acres in Penn and Forward Townships and began drilling near the settlement of Bald Ridge on the Connoquenessing Creek. In the spring of 1881, oil was struck at 1,620 feet on the Smith farm, resulting in a 6-barrel-per-hour well. Success prompted the formation of the Bald Ridge Oil and Transportation Company in May 1881. Its directors were: J.D. McJunkin, John S. Campbell, Fred Reiber, S.H. Peirsol, W.D. Brandon, W.H. Hoffman, J.A. Hawk, H.L. Westerman, W.H. Ritter, R.P. Scott, G.W. Fleeger, John N. Patterson, D.A. Heck, H.A. Krug, Jr., George Krug, O.D. Thompson, W.C. Neeley, Henry Bauer, Philip Bauer, B.C. Huselton, M. Reiber, Harvey Colbert, H. Eitenmiller, Jacob Reiber, and Simon Yetter.

Several wells were completed in the Bald Ridge field in 1881. Other operators in the field included Simcox and Myers, who began drilling in 1881 near the community of Bald Ridge. The following year Agnew and Egbert began drilling on the McCalmont farm, less than a mile north of the confluence of the Connoquenessing and Thorn Creeks. The McCalmont farm ultimately proved to be one of the most valuable tracts in the district. Two other companies joined oil exploration at Bald Ridge when the Forrest Oil Company purchased one-half interest in the Simcox and Myers leases and Yeagle and Campbell purchased the Smith farm, where initial Bald Ridge drilling had begun.

In August 1882, the Bald Ridge Oil and Transportation Company sold their leases, equipment, and wells to Phillips Brothers Company for $160,000. With the sale, an oil pipeline was extended south from the fields around Petrolia, in northeastern Butler County, to the new Bald Ridge field. In December 1882, Phillips Brothers leased portions of the Wallace farm, which adjoined the Renfrew property where the D. Renfrew Oil Rig is located (see **Detail of Bald Ridge and Thorn Creek Oil Fields, 1886**). The Wallace farm became one of the most

profitable farms in the district. By 1883, there were 47 wells in the Bald Ridge field, of which 37 were producing a total of 642 barrels a day (Sipe 1927; *History of Butler County, Pennsylvania* 1895).

The development of the Bald Ridge field accelerated when Thomas W. Phillips, an operator in the upper and middle oil fields, refused to follow scouts to newly discovered fields in McKean County, instead opting for exploration in Butler County. A native of Lawrence County, Phillips went to Oil Creek in 1861 where he formed a partnership with his eldest brother Isaac and brothers John and Charles. By 1873, the Phillips Brothers firm was among the largest producers in the Parker and Troutman fields. During the oil price depression of 1873, however, the Phillipses became heavily in debt, owing creditors $800,000 for loans related to oil exploration. Under great financial pressure, T.W. Phillips, who operated individually after the death of his brother Isaac, began vast oil exploration. Within 15 years the debt was fully repaid, largely with profits from the Bullion pool in Venango County (1876) and the Thorn Creek field in Butler County (1884) (Crum 1911; Sipe 1927).

T.W. Phillips was pivotal in the development of the Butler County oil industry, using success in the Thorn Creek, Glade Run, and Thorn Creek Extension fields to grow into one of the largest and most successful firms in Pennsylvania. In 1890 the name of the firm became T.W. Phillips Sons and Company. In 1904, T.W. Phillips Gas and Oil Company was formed after acquisition of the Home Gas Company of Butler, the Enterprise Natural Gas Company of Freeport, and the Citizens Fuel Company of Punxsutawney (Crum 1911). At the time of Phillips's death in 1912, his company owned 850 oil and gas wells, 900 miles of gas pipeline, and a great amount of oil and gas leases throughout western Pennsylvania (Sipe 1927). As chronicled in one of Butler County's superb local histories, "the development of the oil fields of Butler County and the oil business generally in western Pennsylvania owes more to the Honorable Thomas W. Phillips than any other man living or dead since the beginning of oil operations in 1859" (McKee 1909).

T.W. Phillips's success in the Thorn Creek field stemmed from his belief that there were significant oil deposits near the confluence of the Connoquenessing and Thorn Creeks. His first wells were not large producers, but the nature of the wells and the geological formation of the area confirmed his theory that profitable wells were located in the vicinity. On August 29, 1884, Phillips hit paying sand on a well that at first was not predicted to be productive. As drilling went deeper, however, it flowed 225 barrels per hour by September 3, immediately attracting oil scouts from other fields. By September 15, the well flowed 4,200 barrels per day, making it the best producer in the state (and country) at the time. This Phillips well surpassed the Tarr farm well along Oil Creek (Venango County), which for 23 years had held the initial production record of 4,000 barrels per day. The tremendous volume and potential of the Phillips well caused the price of oil to drop 8 cents per barrel.

The Phillips well attracted oil scouts and dozens of oil prospectors causing, according to one local historian, "a stampede from the upper fields, and in [a] short time Thorn Creek was the scene of one of the largest excitements since the days of Millerstown" (McKee 1909). The gusher also attracted thousands of curious spectators, arriving on special excursion trains from Pittsburgh (Giddens 1964; *History of Butler County, Pennsylvania* 1895; McCorry 1970; Goldinger n.d.).

After the Phillips well was struck, oil scouts established a headquarters at the nearest town, McBride, located less than .5 mile to the east along Thorn Creek. The professional oil scout first became prominent in the early 1880s. Prior to that time, regional and local newspapers were the primary source of information about new wells and fields. Wild speculation often occurred in the oil fields, and accurate information was carefully guarded by successful prospectors. This secrecy resulted in several "mystery wells," often protected at gunpoint. Oil scouts maneuvered at night to spy on mystery wells and monitor activity for their employers, most often oil companies. The telegraph office, quickly erected when a large gusher well was struck, was a main focus of attention for the oil scout (Giddens 1964; McCorry Collection, Butler County Historical Society).

In early October 1884, just 360 feet west of the Phillips well, also on the Bartley farm, the Christie well was begun. This well surpassed the Phillips well by producing over 5,000 barrels the first day, 7,000 barrels per day for several days, and a sustained high volume for a month. The Christie brothers refused an offer of $100,000 for the well. On October 27, 1884, about 400 feet south of the Phillips well on the adjacent Marshall farm, Colonel S.P. Armstrong drilled the famous Armstrong No. 2 well, which flowed 8,800 barrels for the first 24 hours. Production gradually dropped, however, to 6,000 barrels by November 1, and 600 by December 1, before it stopped completely on December 2.

In the history of Pennsylvania oil production, the Armstrong No. 2 well's production rate was surpassed by only two other wells, both located in Allegheny County (Giddens 1964; McCorry 1970). The excitement of the Armstrong well, which initially appeared to be a "dry hole," is vividly recorded in the local histories:

> On October 26 [1884] the Armstrong was drilled through the sand with no show of oil.... One of the scouts laughingly offered Armstrong a cigar for the well. Armstrong thought this just could not happen, for a well to be within 500 feet of other tremendous gushers and be a 'dry hole'. At noon on October 27 he made arrangements with the 'torpedo man' to try a 60 quart nitroglycerine torpedo in the well, where the pay sand should be. All scouts, oil prospectors, and sight-seers cleared from the derrick to the school yard and the telegraph carriage across the wagon-road, near the Phillips [well]. The torpedo man dropped the 'go-devil' (a triangular piece of metal to explode the shell); a few moments of silence, then

> a heavy earth rumble--gas vapors started to cloud the derrick--then a rain of pebbles and slate. A few more seconds went by and there was a six-inch diameter golden colored column, straight as a mountain-pine until it was broken into rain fragments 80 feet above at the crown-pulley--THE JUMBO OIL WELL STRUCK (McCorry 1970).

By November 1884, Thomas Phillips had six new producing wells on the Bartley farm and Dodds farm, adjacent to the Wallace farm to the east. By December 1, Phillips and others had 24 wells in operation, with 29 more being drilled. Other operators who found oil on these two farms were Boyd & Semple, Conner & Fishel, Greenlee & Company, Gibson & Company, and several small operators drilling around the edge of the pool. Within only a few months, production from the Thorn Creek field was totalling 16,000 barrels per day. By 1885, tbere were 147 producing wells in the Thorn Creek field. The 1886 Heydrick map shows the Bartley and Dodds farms as the most densely drilled area on Thorn Creek (Sipe 1927) (see **Detail of Bald Ridge and Thorn Creek Oil Fields, 1886**).

Immediately after the Phillips well was struck in August 1884, the boom town of Phillips City was quickly built on top of the oil pool under the Bartley and Dodds farms (see **Detail of Bald Ridge and Thorn Creek Oil Fields, 1886**). By November, bolstered by the success of the Christie and Armstrong No. 2 wells, the town had spread south, occupying both banks of Thorn Creek. New buildings were erected to serve the workers and their families, including two boarding houses, a grocery store, a school, and two telegraph offices. Scores of new dwellings and large oil storage tanks were also constructed. But on December 19, 1884 five storage tanks caught fire, destroying much of the town and causing over $11,000 in property damage. By 1886, the boom towns of Phillips City and McBride City, located .75 mile to the east on Thorn Creek, had fallen into decay, as well pressures dropped and drilling activity migrated to new fields in Parker Township (Goldinger n.d; McCorry 1970).

Thorn Creek field's reign as the largest oil producing field in the world was relatively brief, reflecting the great mobility of an industry that constantly sought new areas to drill. Compared to other extractive industries--coal mining, for example--the average life expectancy of an oil boom town was brief. Often, as in the case of Phillips City, it lasted less than two years. Although boom town wells continued to produce oil in paying quantities, production usually subsided after they were initially "creamed" of high initial volumes for several months (Packard Interview 1992). Oil company workers and independent operators who lived in a boom town usually stayed until the volume of oil decreased significantly or until new oil fields were discovered.

During the late 1880s and 1890s, the principal oil centers of Butler County were confined to Jefferson, Cranberry, Lancaster, and Penn Townships. The Brownsdale field was found in the latter township, created by the striking of another

Phillips well. In 1894, the deepest well (2,005 feet) in Butler County up to that time was drilled in this district on the Campbell heirs' farm in Middlesex Township by McJunkin and Brandon. It was predicted that Cooperstown would be the last large development in Butler County, but oil was struck in Campbell Hollow in Concord and Washington Townships, which produced 3,000,000 barrels in a 4- to 5-year period.

In addition, the Thorn Creek field was revived in 1908 on the Dodds farm, and during the first decade of the twentieth century the South Penn Oil Company, Phillips Gas and Oil Company, Culbertson and McKee, and McCollough and Bernard were all operating in the district. Nonetheless, by 1902 the main producing areas in the vicinity were discovered and drained of their maximum yields.

The height of Butler County's oil production occurred between 1870 and 1890. By the 1890s, petroleum discoveries in other areas of the U.S. and the expansion of the industry world-wide made Pennsylvania oil expensive by comparison. Butler County is distinguished, however, for having wells with record-setting initial capacity and also the longest life of any Pennsylvania wells. Many Butler County wells are still in operation today, and when the price of oil rises significantly, many old wells are reopened (Richardson 1936; Doherty 1989).

Technological Development of Oil Field Equipment

In discussing the use of oil field equipment, it is important to note that it is nearly impossible to identify a date that a certain class of equipment came into universal usage. The primary reason for this condition is that oil field equipment generally has a long life, and was used, rebuilt, modified, or abandoned to minimize production costs. In the oil industry particularly, basic types of equipment were used for very long periods, making modernization at particular wells unprofitable. This fact is reinforced by the nature of oil wells, which generally produce large volumes of oil initially, then quickly decrease production as pressure drops and oil pools are drained of their maximum yields. It is possible, however, to identify trends in equipment development and the approximate dates of major innovations.

From the drilling of the Drake well in 1859 through the early twentieth century, the oil fields of Pennsylvania were exploited by essentially the same extraction technique. The cable-tool system, also known as the percussion or churn-drill method, was developed during the earliest period of oil exploration, and it survived as the standard drilling method in American oil and gas fields until the widespread adoption of the rotary system beginning in the 1930s. In Pennsylvania's hard rock formations, the cable system remained the preferred method, while the rotary system was well suited for the softer soils of the Texas and Gulf Coast fields.

With the cable system, a heavy steel bit suspended from a rope or wire cable was raised by cable through the center of the derrick and dropped into the well hole, pounding its way through the rocks. The system was particularly good for drilling in hard formations because the sides of the hole remained intact despite the force of the percussion, allowing the driller to see if water or gas strata were hit before a casing was inserted.

Certain preconditions had to be met before drilling could begin. The abundance of water sources, coal, and timber meant that the Pennsylvania oil fields did not have the problems of extraction associated with later western fields. Drilling could begin only after the erection of a power plant and derrick, with necessary drilling tools, casings and other equipment brought to the site. All oil or gas drilling required an adequate water supply to run the steam boilers that powered the drilling and pumping equipment. Steam was the prevalent form of power into the early 1900s. Steam engine boilers were fueled by wood, coal, natural gas, or oil, depending on local conditions (*The Petroleum Industry*... 1934).

Until the adoption of iron and steel equipment, timber was necessary for the construction of derricks and other features of the rig. After steel derricks became available beginning in the 1880s, many derricks continued to be made out of wood, which had the advantage of giving under stress. Rigid tubular steel derricks lasted longer and were not threatened by the fire hazard in closely drilled areas. Steel derricks were also easily dismantled and reassembled, making them portable and offsetting their initially higher cost (Phelps and Lake 1924). Derricks were also frequently made from the abundance of spare pipe in the oil fields, joined together with a variety of patented joints.

Derricks were usually between 60 and 90 feet tall. Deeper wells contributed to the use of a derrick at the site after the well was drilled because derricks reduced labor during servicing. Compared to a portable "pulling machine," also used to remove tubing in the early twentieth century, a 80- or 90-foot derrick allowed the removal of twice the pipe per pull. The greater well depth in the lower oil district, including southcentral Butler County, has contributed to the survival of some old derricks in that district. By contrast, virtually no derricks survive in Venango County, and only a few are known to exist in the Bradford area of McKean County, where the wells were shallower (Packard Interview 1992).

Timber foundations for drilling and pumping equipment were often of standardized sizes. When the well was started, a hole was dug, often 10 to 15 feet to bedrock, for inserting the drilling tools. When the bedrock was too deep, an iron drive-pipe attached to a sharp, steel "shoe" was driven into the formation to reach the height of the suspended tools. If the bedrock was less than 60 feet from the surface of the ground, the process known as "spudding" was necessary because the boring tools could not be operated from the walking beam of the derrick until the tools were below the derrick floor. During the spudding process, the drilling tools

were raised and dropped from a cable with a "jerk rope" held by the driller and attached to the axle of the bull wheel. The tools would be raised and dropped over the hole with the driller turning the drill to ensure that the hole was round. By pulling and slackening the rope, the driller performed manually the function of the walking beam until the necessary depth was reaehed (Carll 1880).

The bull wheel was usually a set of wheels, constructed first of oak and later of iron or steel, with a brake on one side controlled by the driller. Driven by a 2-inch bull rope with iron couplings, the bull wheel was used to withdraw tools from the hole. One end of the drilling cable was attached to the bull wheel, around which the cable was spooled. The cable passed over a crown pulley attached to the top of the derrick before running through the temper screw, fastened to the end of a walking beam, and from there the cable passed into the hole. Drilling occurred by raising and lowering the clamped end of the walking beam (McBeth 1919).

The drilling crew consisted of a driller, a tool dresser, and an engineer. The driller rotated the drill using a lever inserted into the temper screw. During the process, he lowered the temper screw at intervals allowing the cable to sink into the hole. After the tools were pulled from the hole, the dresser removed the bit for sharpening, and a bailer or sand pump was inserted to clear crushed material and water. The sand pump used a separate cable line which also passed over the pulley. In cases where water or soft sides were encountered, casings were inserted and drilling resumed with a smaller bit.

In the hard rock formations of the western Pennsylvania oil fields, casings often were not necessary, and drilling was possible to depths of 2,600 feet without casings. Hard rock meant slow progress, however, as the earliest drilling crews could only accomplish about three feet per day (Eaton 1912). At that rate, a well 1,500 feet deep took more than one year to complete. As described by John Carll in 1880, the routine of drilling was "very monotonous, unless some accident occurs to diversify it" (Carll 1880, quoted in Bacon and Hamor 1916).

The process of "shooting" a well was used in hard rock formations, in densely packed sands, or where existing gas pressure was insufficient to allow the oil to flow. In the Pennsylvania fields, nitroglycerin was selectively used on nonproductive wells. The explosion created a reservoir at the bottom of the casing to collect any oil. Shooting was also sometimes used when production of an established well dropped to a point where it was unprofitable.

Before tbe 1870s, narrow wells often became filled with water during drilling. Water required pumping and reduced the speed of drilling, while the narrow casings dictated the use of light-weight drilling tools, which also slowed the process. Although the process of drilling remained basically unchanged, technological advances by the 1880s contributed to more efficient production. One development was the increased weight of the cable tools from 100 to 200 pounds to sets weighing

2,000 to 3,000 pounds. During this period, the mechanics of drilling operations were simplified with increases in the horsepower of the boilers and engines. Stronger machinery and tools and increases in power were necessary as wells were dug deeper and larger, requiring larger casing ranging from 5-1/2 to 8 inches (Brantly 1971; *The Petroleum Industry...* 1934).

By the 1890s, technological improvements continued, especially in materials and size of drilling equipment. A declining lumber supply and the growth and proximity of Pittsburgh steel mills contributed to the use of iron or steel for many oil field components. Derricks, jack posts, and walking beams of steel were developed in this period, as well as wire drilling lines (Brantly 1971; *The Petroleum Industry...* 1934).

Steam boilers and steam engines furnished the power for drilling and pumping during the early phase of the oil industry. Single cylinder gas engines came into use in 1894 and by 1910 replaced steam engines for pumping wells. Gas engines utilized natural gas drawn directly from the well head with a suction pipe and compressor. During the 1890s, manufacturers developed combination engines with convertible steam and gas cylinders to utilize the advantages of each method. Despite the development of reversible clutches for gas engines circa 1901, the more powerful steam engines continued to be preferred for drilling and servicing operations until about 1935, when the cable tool method gave way to rotary drilling. Rotary operations employed multiple cylinder internal combustion engines (*History of Petroleum Engineering* 1961; Brantly 1971; Beeby-Thompson 1950).

Successful oil wells required sufficient natural gas pressure to naturally raise oil above ground level. After the pressure dropped, a pump was installed on wells with the potential to be productive for long periods. In the older, partially depleted oil fields of western Pennsylvania, pumps were often necessary for new wells drilled after the boom period.

Varieties of beam pumping to raise the oil up from a non-flowing well were used on the first oil rigs and continue to be used today on modern unit pumpers. In principle, oil lift pumps are similar to those used for the deep pumping of water, working on the principle of displaced air. The relationship between pumping motions and loads is complex, however, and was not fully understood until the 1920s, resulting in many experimental beam pumping innovations, most of which did not gain general acceptance. Examination of supply catalogs and trade journals from circa 1900 to 1920 illustrates the transition from powering by band wheel to various types of the smaller unit "pumping jacks," made mostly of iron and steel. Pumping jacks were an improvement because their power trains were directly connected, eliminating the large belt and wooden band wheel of the older type. The most common type of pumping jack employed a set of spur gears driven by the engine crankshaft, including a small spur gear to reduce the speed of revolutions for

pumping. Chain-driven sprockets were also common variant in the 1910s and 1920s (*History of Petroleum Engineering* 1961).

In relatively shallow oil fields where wells are close together, central pumping units were often used to pump several--and as many as 20 or 30--wells at one time, with the pumping strokes synchronized for constant oil pool pressure and maximum pumping efficiency (Eaton 1912). This method was common in the upper and middle oil districts, and as far south as northern Butler County. The deeper wells of central and southern Butler County, spaced farther apart compared to areas northward, relied almost exclusively on individual pumping jacks (Levin 1941; Weber Interview 1992).

Butler County's oil fields generally contained a lot of water, requiring larger than average pumping equipment because water is heavier than oil. Also due to the presence of water, Butler County rigs often operated 24 hours per day to constantly pump water out. Compared to wells of the upper district (centered in Venango County), Butler County wells generally had larger tubing, up to 3 inches in diameter compared to standard 2-inch tubing. Separator tanks were also common in Butler County, used at the site to separate water from oil (Packard Interview 1992).

When the oil pressure of a well dropped significantly, various repressurization methods could be used. Natural gas was used to inject pressure into old pools. Gas could also be pumped into the head of a well and forced to the bottom, where it mixed with oil and expanded, lifting the frothy oil to the surface. Compressed air, without a pump, could be piped into the bottom of a well with the same result. By the 1920s, vacuum pumps were used to change the pressure differential, but this method was sometimes inefficient due to leaks. Other methods involved repressurizing with steam or water. The latter method was considered a last resort, however, because its failure could result in the loss of the oil reservoir (Phelps and Lake 1924). In Butler County, the most common method of repressurization was gas injected into both wells and pools. In both the Bald Ridge and adjacent Thorn Creek oil fields, vacuum pumps were used exclusively with success; no other secondary recovery methods were ever tried (Lytle 1950).

By the 1920s, new technological improvements were transforming oil extraction. During the 1920s and 1930s, oil production became more precise with sophisticated geological equipment and increased knowledge of subsurface geology. It became possible to drill a straight vertical hole to reach a predetermined point at the bottom. Wire line core barrels were invented to take samples of formations; electrical logging devices were used in rotary drilled holes to determine permeability, porosity, and the oil and gas contents of the sands. Improvements in materials and tool casting continued in the mid-twentieth century, as oil wells were dug at depths of 10,000 to 14,000 feet. The greater depths demanded heavier equipment made of harder metals and alloys, as well as more accurate measuring instruments (Clark 1958).

Rotary drilling, developed in the early 1900s, was more expensive than the standard cable system. With this system, the bit was rotated by a gear, operated by a gas or steam engine. A pump sent water through the drill stem to the bit with the water returning through the outside of the stem. The water kept the bit cool and removed debris from inside the hole. The rotary system was used primarily along the Gulf Coast and in some parts of California, where the formations were very soft. The bit used for the rotary drill was developed by the father of millionaire Howard Hughes while employed at Price Brothers Machine and Boiler Shop in Renfrew, Pennsylvania. Hughes moved to Texas, where he made his fortune from the use of his rotary bit in the new oil fields (Goldinger n.d).

In the late nineteenth and early twentieth centuries, the two largest oil equipment supply companies were the Oil Well Supply Company and the National Supply Company, both represented by surviving components on the D. Renfrew Oil Rig. These companies supplied an array of equipment, including derricks, rigs, boilers, steam and gas engines, drilling tools, cables, pipes, and fittings. The Oil Well Supply Company was created by John Eaton, who migrated to western Pennsylvania from Massachusetts after the Drake well was struck. In the early 1860s, Eaton established the firm of Eaton, Cole and Burnham, which in 1878 became the Oil Well Supply Company. This company began with its main manufacturing department in Oil City. By 1902, it had additional factories in Pittsburgh and Bradford, Pennsylvania; Oswego, New York; Parkersburg, West Virginia; Van Wert, Ohio; and Poplar Bluff, Missouri. It also had 25 branch stores in all the major oil districts, as well as several agencies handling international trade. At Harmony, a small railroad junction town on the Connoquenessing Creek about 10 miles west of the D. Renfrew Oil Rig, the Oil Well Supply Company had a machine shop and forge for manufacturing tools and repairing engines (*The Petroleum Industry...* 1934; Crum 1911; *Derrick's Handbook of Petroleum* 1898).

The firm of Bayne, Wilson and Pratt--formed in 1875 to supply the busy Bradford oil field--was enlarged and incorporated as the National Supply Company in 1894. This company was closely related to the National Transit Company, a subsidiary of the Standard Oil Company. With the acquisitions of the Buckeye Supply Company serving Ohio, Indiana, and the west, and Shaw, Kendall & Company of Toledo, the National Supply Company quickly became the largest manufacturer of oil supply equipment in the world, with major manufacturing plants in Pittsburgh and Toledo (*The Petroleum Industry...* 1934; Crum 1911; *Derrick's Handbook of Petroleum* 1898).

Other oil supply manufacturers in western Pennsylvania included: Bovaird & Seyfang Manufacturing Company, Bradford; Titusville Iron Company, Titusville; Ajax Iron Works, Corry; and the Oil City Boiler Works, Oil City. By the early 1900s, the lower oil district (including Butler County) also developed several manufacturers. Many of these were located in Butler, including: T.W. Phillips Manufacturing Company, Evans Manufacturing Company, Kesselman & Company,

Larkin and Company, Masseth Packer and Machine Works, and Etna Manufacturing Company (*Oil and Gas Man's Magazine* 1907-1913).

SOURCES OF INFORMATION

The written narrative and graphics resulted from research at a variety of federal, state, and local repositories, archives, and agencies including: the Library of Congress, Washington, D.C.; Smithsonian Institution, Division of Agriculture and Natural Resources, Division of Engineering and Industries, Washington, D.C.; National Park Service, HABS/HAER division, Washington, D.C.; American Petroleum Institute library, Washington, D.C.; United States Geological Survey, Cartographic Information Section library, Reston, Virginia; University of Pittsburgh library, Pittsburgh; Carnegie Library, Pittsburgh; Historical Society of Western Pennsylvania, Pittsburgh; Butler County Courthouse, Butler, Pennsylvania; Butler County public library, Butler; Butler County Historical Society, Butler; Pennsylvania Geological Survey, Pittsburgh; Pennsylvania Bureau of Archives and History library, Harrisburg; Drake Well Museum archives and library, Titusville, Pennsylvania; and the Cool Spring Power Museum library, Cool Spring, Pennsylvania.

Tape-recorded oral interviews, telephone interviews, and correspondence with specialists in oil industry technology and local residents familiar with this structure and its locality were also very important for this documentation. These interviews are included in the Bibliography.

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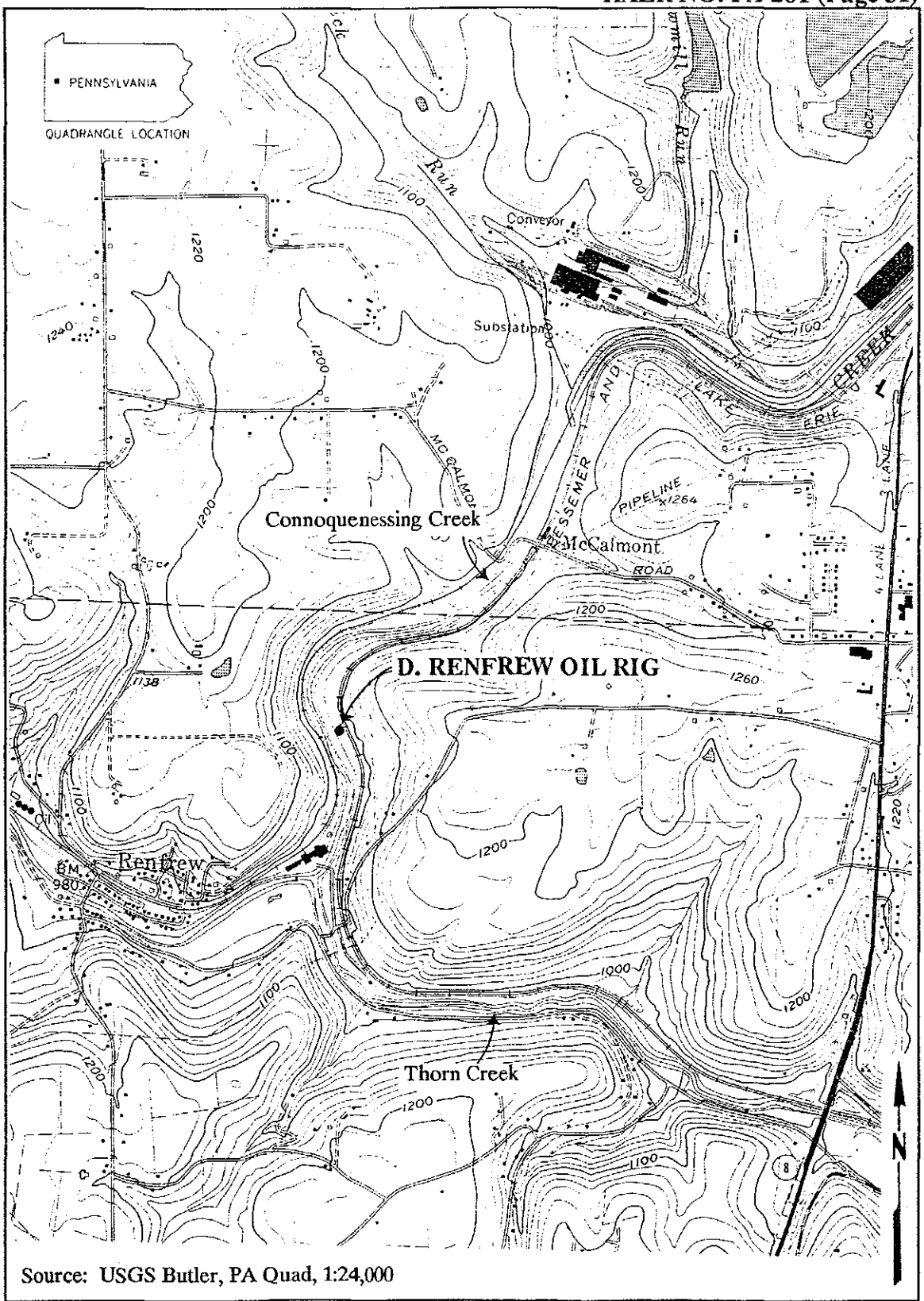
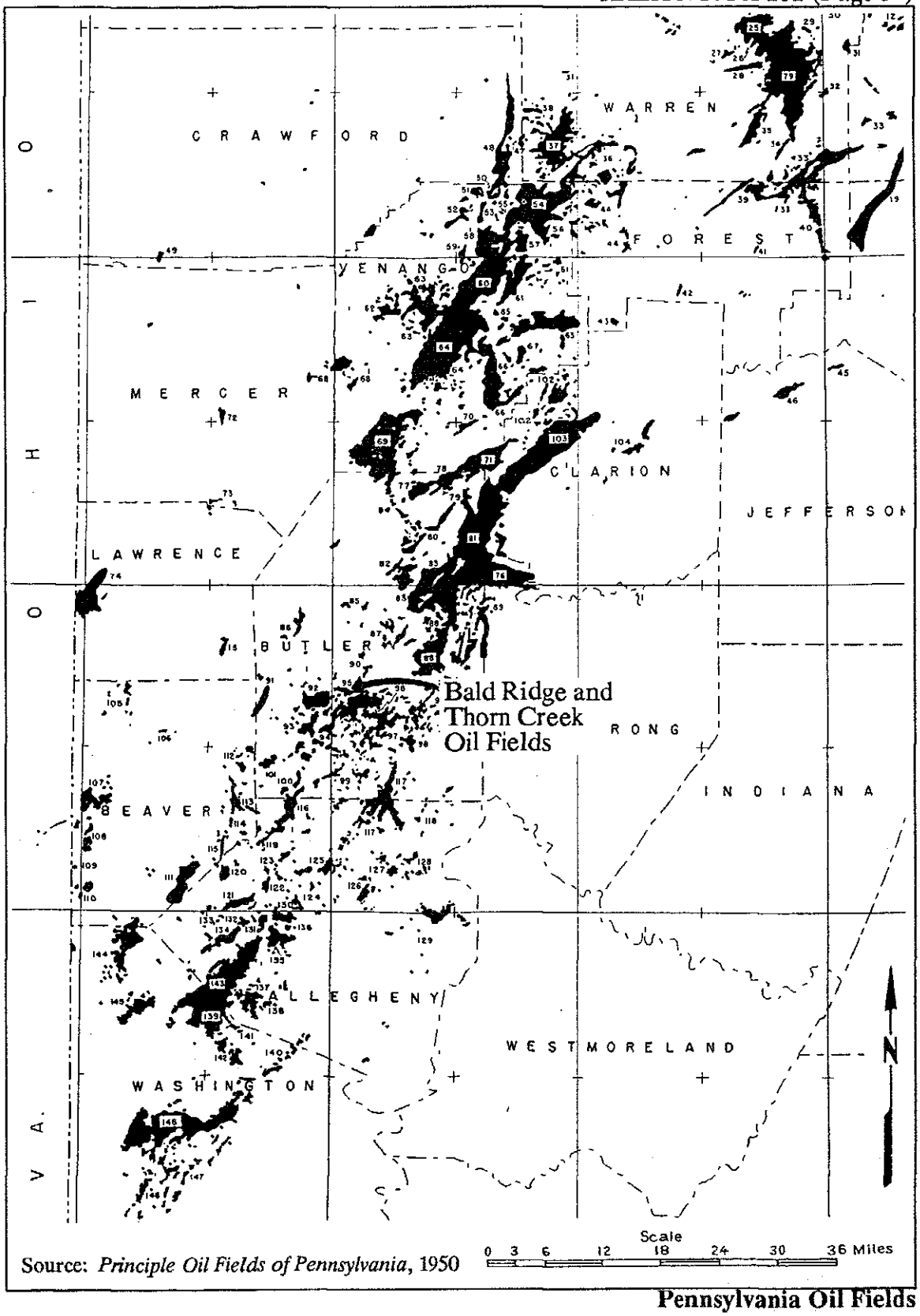


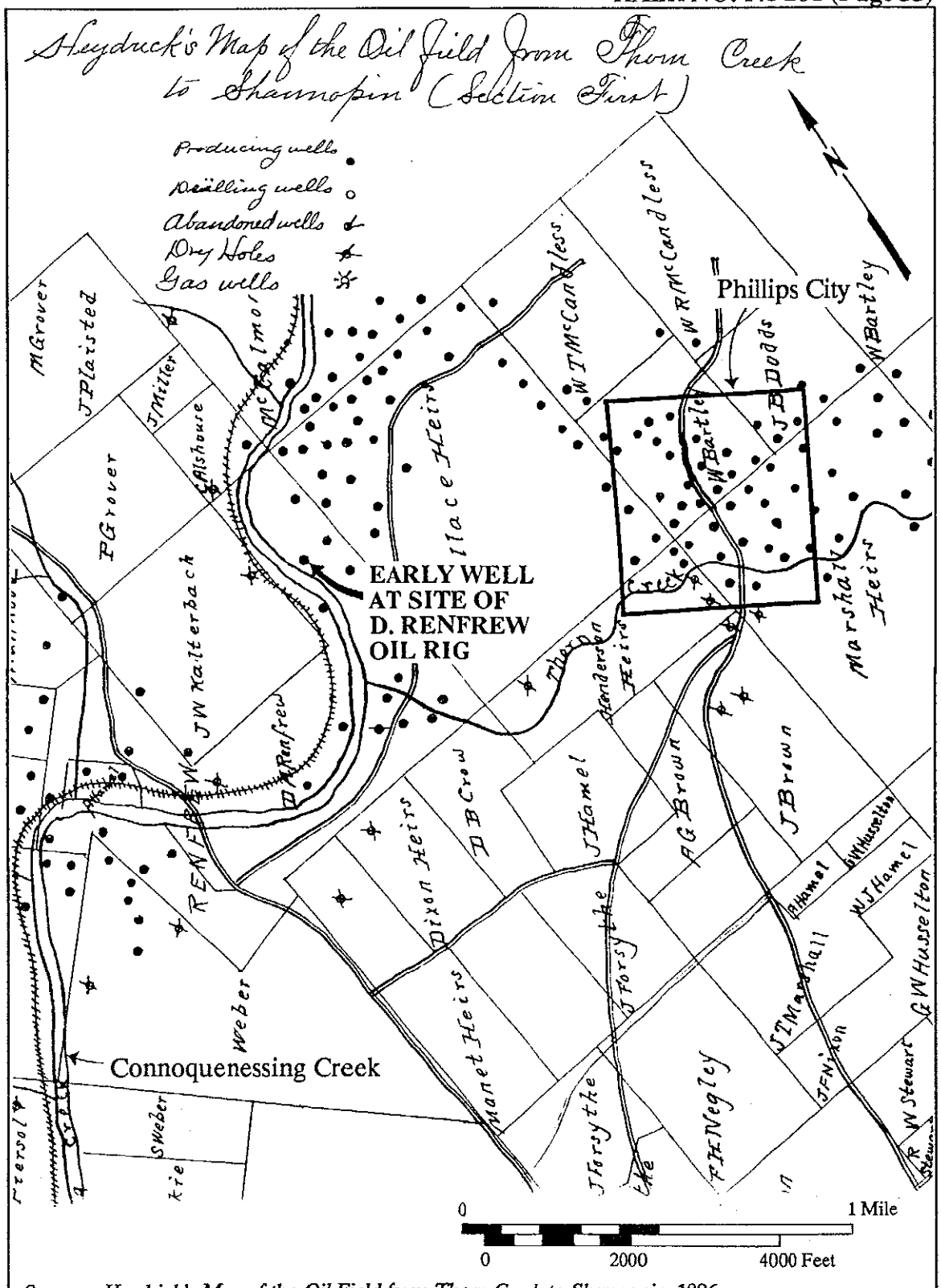
Source: USGS Butler, PA Quad, 1:24,000

Location Map



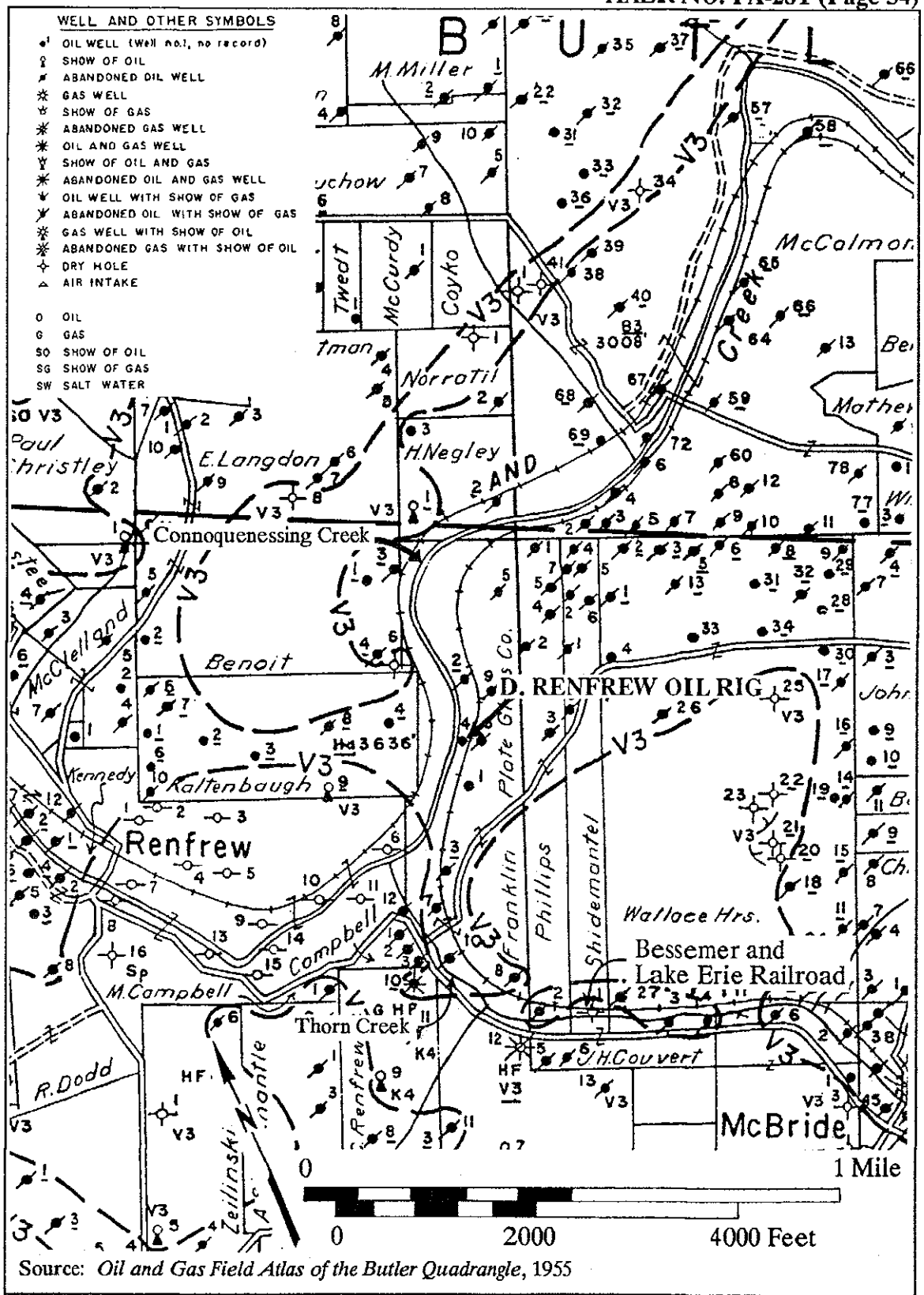
Source: *Principle Oil Fields of Pennsylvania*, 1950

Pennsylvania Oil Fields



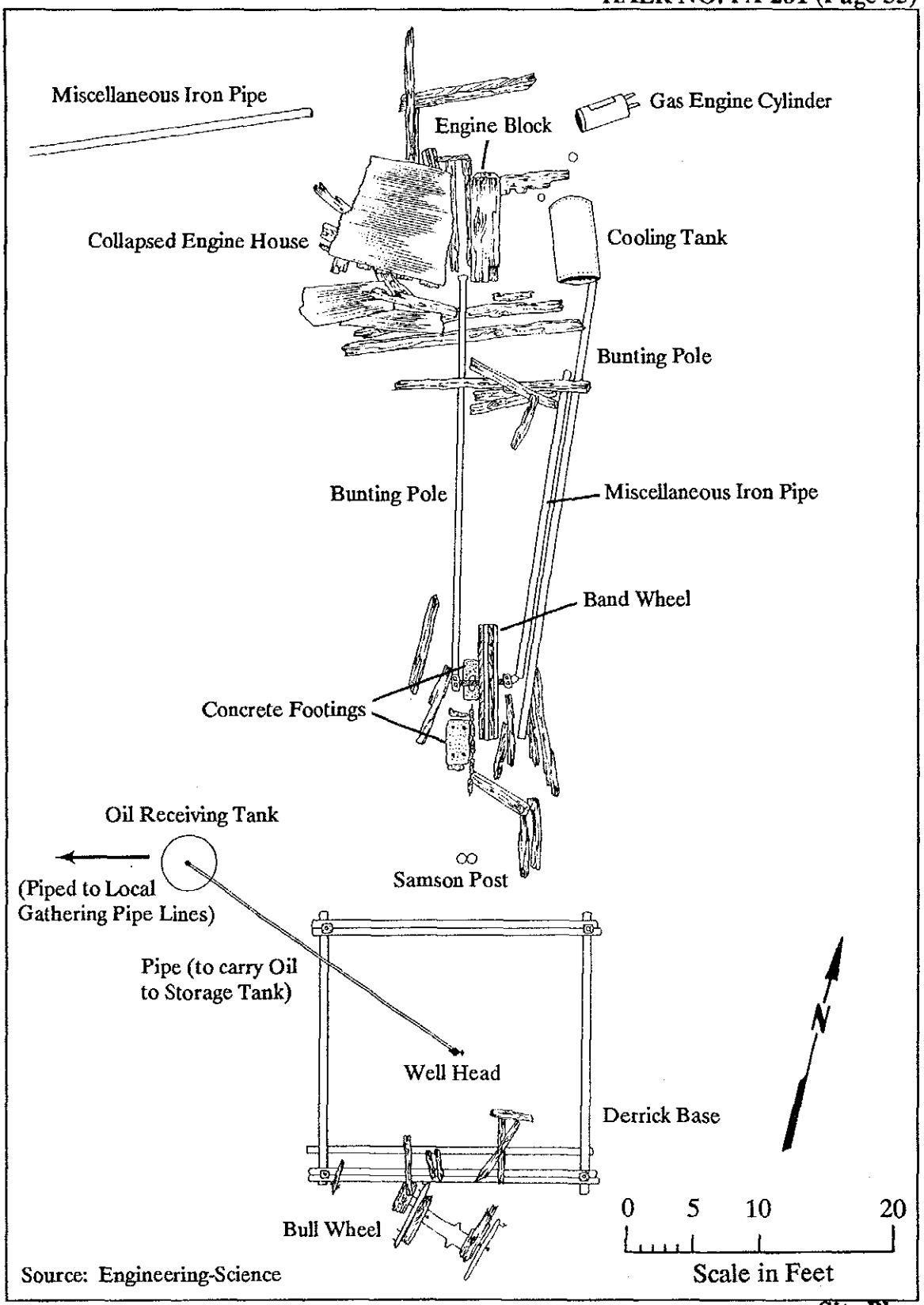
Source: *Heydrick's Map of the Oil Field from Thorn Creek to Shannopin*, 1886

Detail of Bald Ridge and Thorn Creek Oil Fields, 1886

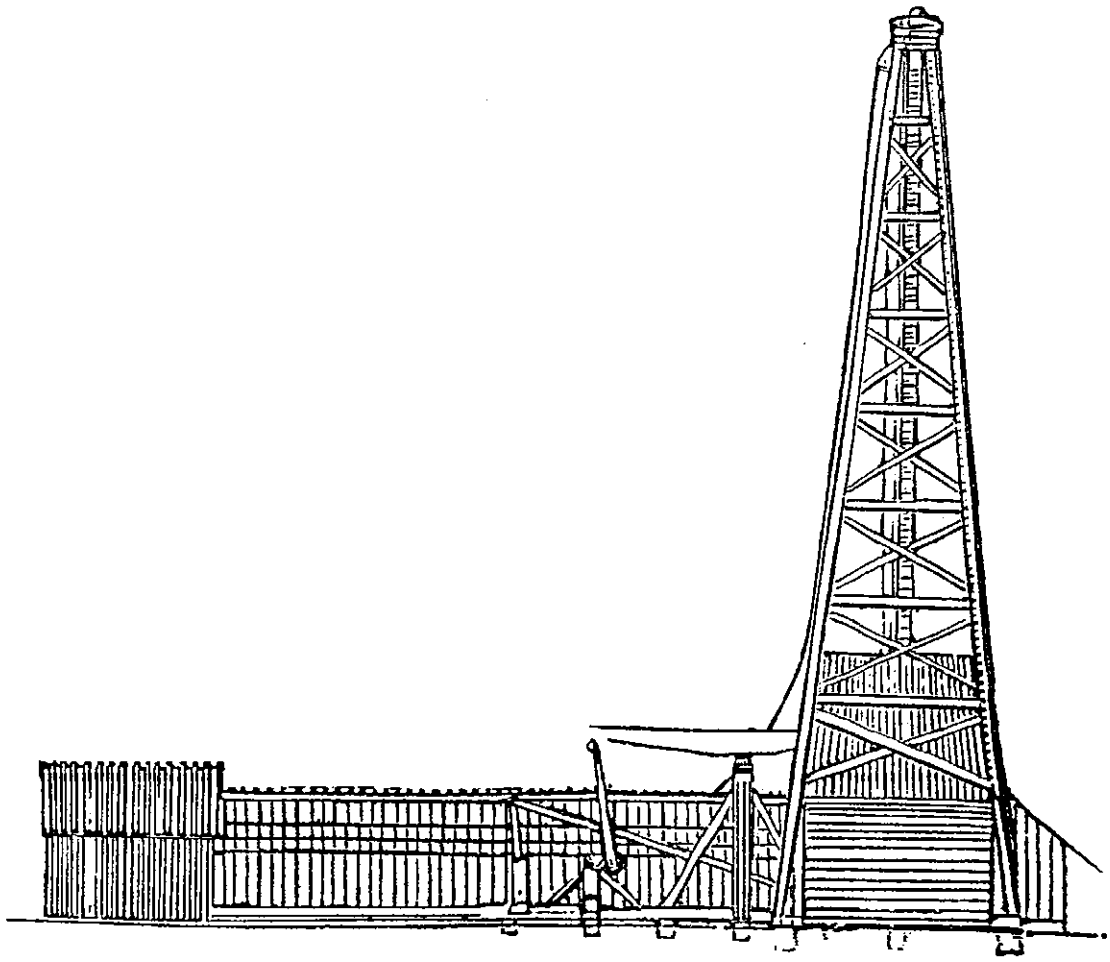


Source: *Oil and Gas Field Atlas of the Butler Quadrangle*, 1955

Detail of Oil/Gas Leases in Butler County, 1955


Miscellaneous Iron Pipe
Engine Block
Gas Engine Cylinder
Collapsed Engine House
Cooling Tank
Bunting Pole
Bunting Pole
Miscellaneous Iron Pipe
Band Wheel
Concrete Footings
Oil Receiving Tank
(Piped to Local
Gathering Pipe Lines)
Samson Post
Pipe (to carry Oil
to Storage Tank)
Well Head
Derrick Base
Bull Wheel
N
0 5 10 20
Scale in Feet
Source: Engineering-Science

Site Plan



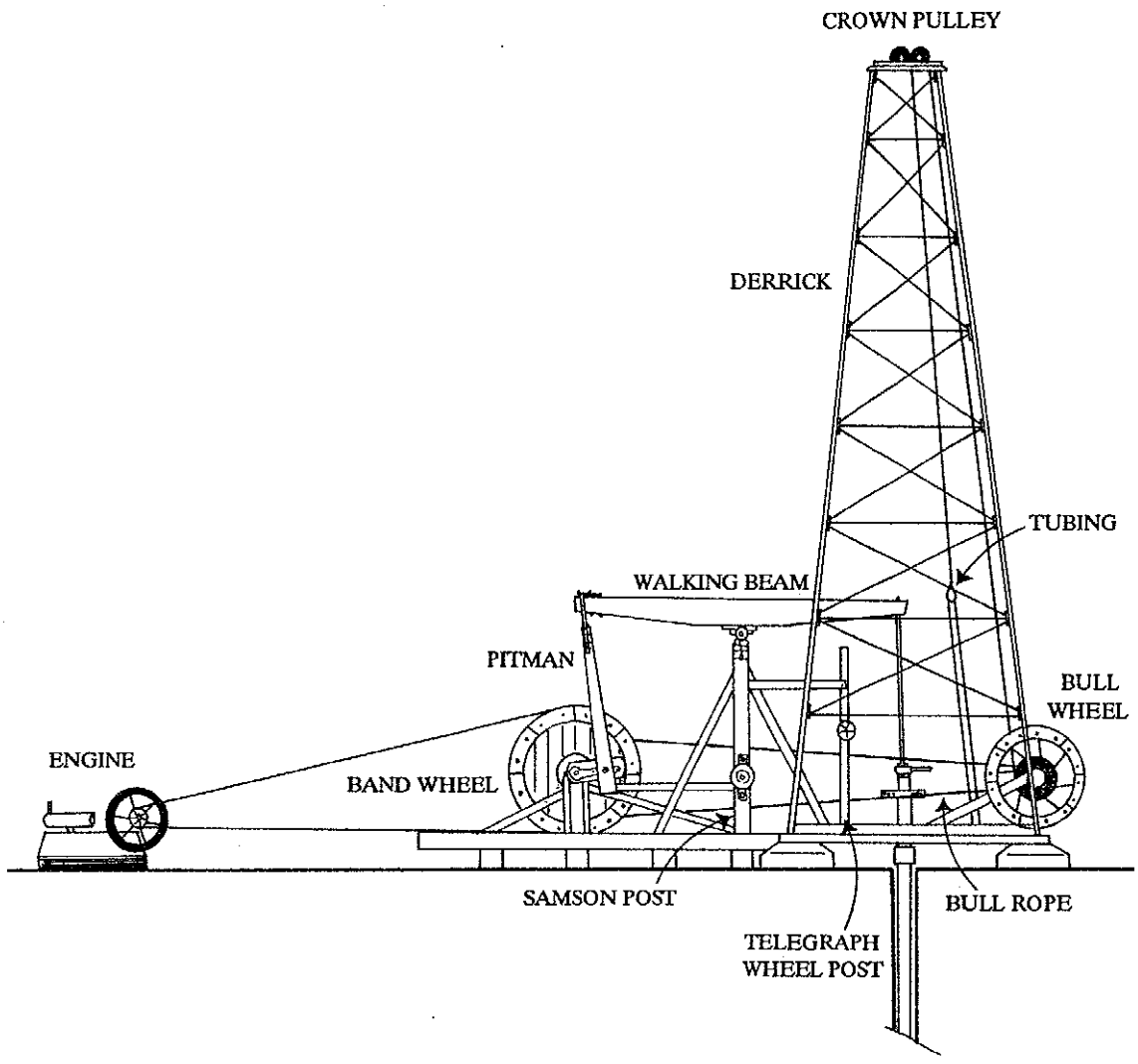
Engine House. Belt House from Engine. House to Derrick. Derrick.

WINTER RIG.

The lower part of the derrick is enclosed to protect the machinery and workmen from cold or stormy weather.

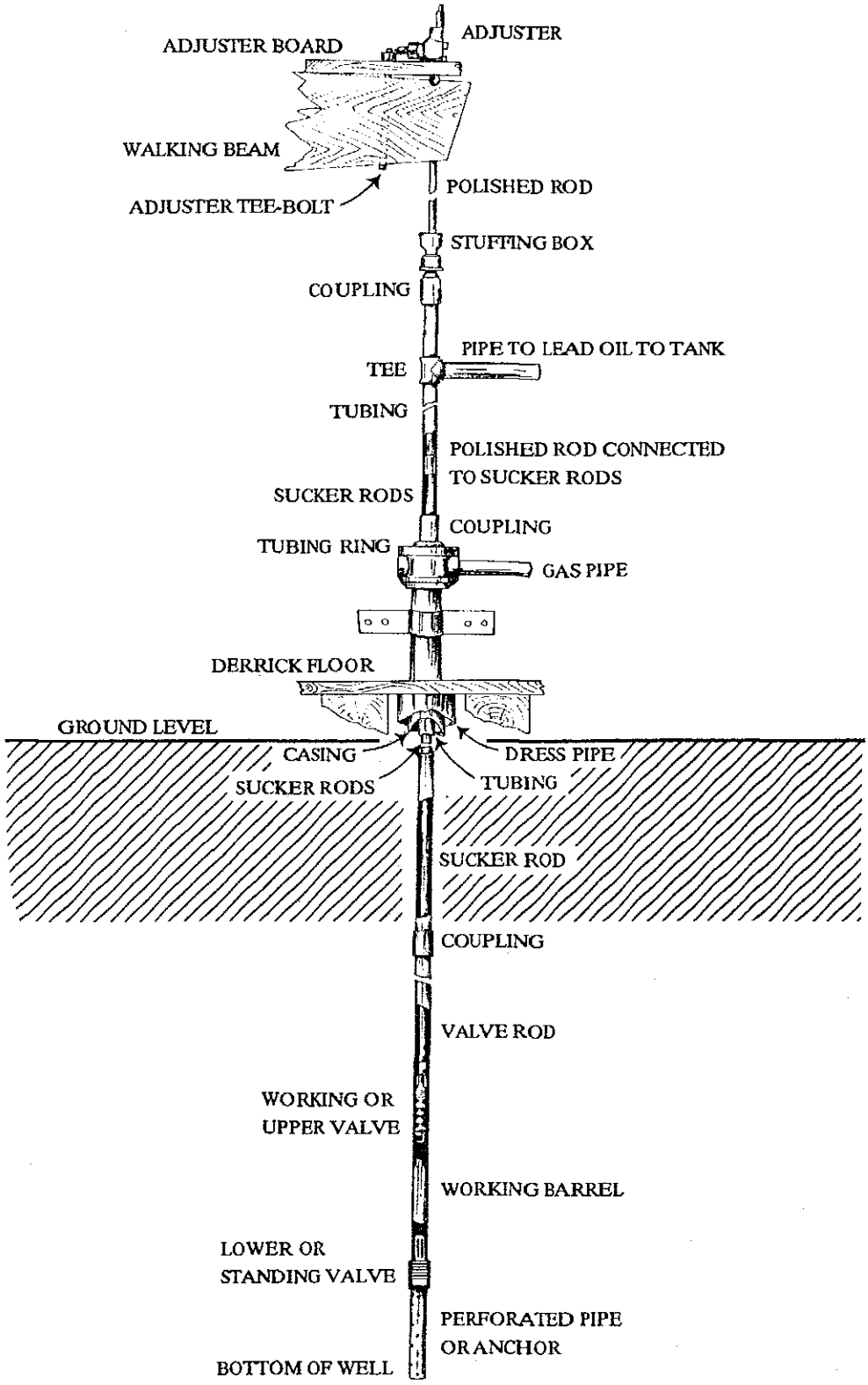
Source: Oil Well Supply Co. *Price List*, 1902

Enclosed Oil Rig, C.1902



Source: Adapted from *Petroleum Encyclopedia*, 1941

Typical Oil Rig Set Up for Pumping, C.1900



Source: Adapted from *Handbook of the Petroleum Industry*, 1922

Detail of Typical Pumping Assembly, C.1900